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An ergonomic study on the UP-Dilimanjeepney driver's workspace and driving conditions

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Abstract

The Philippine Jeepney is one of the most popular, the most accessible and cheapest medium of public transportation in the country. During their driving period, an average of 10 hours a day, the Filipino jeepney drivers are exposed to sustained awkward postures. This research aims to evaluate the drivers' workspace and driving conditions in relation to their anthropometric measurements and their workspace dimensions in order to determine the sources of awkward postures. A comprehensive survey among jeepney drivers inside the UP Diliman campus was conducted to identify the discomforts experienced by the drivers. In addition, a workspace evaluation in comparison with the drivers' anthropometric measurement was also administered to seek out discrepancies that accounts for the discomforts felt. Results reveal that jeepney drivers' working conditions pose danger to their health and safety. For instance, there is an insufficient distance between the steering wheel and driver's seat causing restraint to the drivers' mobility. The limited height of the windshield also blocks the driver's line of sight keeping the drivers leaning forward when looking for traffic signs. Recommendations were made to improve the working conditions of the Filipino jeepney drivers.

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1. Introduction

1.1. Background of the study

From the end of the war between the Americans and the Japanese where hundreds of military jeeps were left behind, Filipinos now make use of the famous jeepneys as part of their everyday travel. These public utility jeepneys (PUJs) are not only one of the most popular icons of Filipino creativity and innovativeness today, but also the most prominent mode of public transportation in the Philippines, with a total of 220,114 registered units in year 2012. [1]

Jeepneys are branded the “king of the road” not only because of their box-framed chassis and their overall aesthetic design, but more predominantly due to the infamous way on how drivers jostle their way in and out of traffic, usually causing congestion and sometimes even accidents. This is because, particularly in the Metro Manila area, jeepney drivers provide higher importance on the need to increase abundance of profit per day than addressing issues on comfort and safety.

These vehicles are constructed by local jeepney manufacturers and are sold to operators as brand-new units. However, it is noted that a large percentage of these utility vehicles that traverse the roads, especially in the cities, are actually overhauled units that are only assembled and fabricated from spare non-matching materials, excess parts, and surplus accessories. These units are modified to fit body capacities, frequently conditional on the specifications of the drivers (or operators) themselves. Most of the time, these customizations are made to increase profitability of the business, leading to health and ergonomic concerns to be neglected. [2]

It is in this matter that designing the structure, in both exterior and interior characteristics, of the jeepneys becomes a strenuous job in the context of considering the over-all safety and appropriateness of each relevant component that affects the working environment of the drivers.

1.2. Significance of the study

In the plight of the increasing number of private vehicles and other modes of transportation for the public masses, public utility jeepneys still remain the most inexpensive mode of transportation in the country. And in producing a higher income yield, factors concerning the environment of the driver, especially in the context of safety and user suitability, are overlooked.

The workspace design of the driver was actually devised without considerations in comfort, causing drivers to undergo various awkward working conditions.[3] And despite the low-priced acquisition cost and transport capacity of these vehicles, it is still important to take into account the conditions of the driver while maneuvering the vehicle, as this work usually goes on for hours of static posture during different weather circumstances, uncomfortable state of driving due to extensive vibrations from the jeepney’s engine, and the jeepney’s utilization of an open-window ventilation instead of an air-conditioning system.

Thus, it is only vital for this study to evaluate these conditions and, upon proper implementation, help jeepney drivers perform their job with pertinent safety both on the aspect of road security and their health. This study aims to give importance in the consideration of the driving conditions of the jeepney driver. Also, this study will be able to help maintain the jeepney as a necessitated means of transportation by initially improving the workspace and driving conditions of the jeepney drivers thus eliminating the possibility of reduction in drivers.

1.3. Problem statement

Since public jeepneys manufactured in the Philippines are produced at minimum cost, jeepneys do not undergo proper design planning procedures that other vehicles are subjected to, thus resulting to poorly designed workspace and undesirable driving conditions detrimental to the health of the drivers.

1.4. Objectives

The average jeepney driver often spend at least 10 hours behind the wheel (Mendoza, 2012).[4] This ergonomic study will focus on improving the workplace layout of the jeepney driver and their driving conditions. This study aims to present a case study on the UP Dilimanjeepneys. Specifically, this study aims to:

- Ergonomically assess the workplace layout of jeepney drivers taking the route of UP Diliman-Philcoa, UP Diliman-Pantranco and UP Diliman-SM North,
- Identify ergonomic hazards that are critical for the work execution of drivers and the improvement of their driving conditions, and
- Develop and recommend an improved jeepney driver's workplace layout to remove avoidable discomforts to the driver and to cater to their concerns. Also, the recommended workplace layout must comply with the existing Land Transportation Office (LTO) regulations.

1.5. Scope and limitations

Based on the objectives and the consideration of time and financial constraints, the following limitations were established for this study:

- The study only considered the jeepney drivers that took the routes of UP Diliman-Philcoa, UP Diliman-Pantranco and UP Diliman-SM North. In comparison with the other jeepney routes that travel through the UP Diliman campus, the three chosen routes were the longest having longer travel time to complete a back and forth trip. In addition, the drivers were more exposed on the road environment outside the campus and were subjected to longer shifts;
- The study did not take into account the mechanical performance of the jeepney, the engine, transmission, and other machine mechanisms that require more than ergonomic analysis;
- The assessed jeepneys did not cover the entire jeepney driver's workspace layout present in the Philippines. It was only limited to the pool of chosen jeepneys that travel inside UP Diliman;
- The measurements in the acquired anthropometric data is not applicable to represent the entire jeepney driver's population in the Philippines, but at least accommodated the average UP Dilimanjeepney drivers; and
- The economic cost for the development of the new workplace layout design of the jeepney was not considered.

2. Methodology

2.1. Gathering of references

Upon identification of the problem, the researchers have gathered sufficient references for the study – such as past research papers related to the study, LTO regulations and other basis for standards regarding the jeepneyspecifications[5]{6}, existing anthropometric data applicable for the jeepney drivers in study, and other necessary data.[7]{8}These data references were used as the criteria for the measurements taken during the actual gathering of data. Also, these were used in the analysis of the study.

2.2. Designing of measurement data form and survey form

The workplace layout was identified to be the jeepney driver's workspace inside the jeepney. Since the study focuses on the improvement of the workspace and driving conditions of the driver, all the vehicle components used while driving were identified. The important concerns regarding these components that could affect the driving condition were also identified. These were classified as quantitative and qualitative concerns.

These classified concerns were used to identify the measurements needed for the study and to design the survey for the driver. The quantitative concerns were used as basis for the measurements included in the data form; while the qualitative concerns were used as basis for the questions included in the survey.

2.3. Selection of test subjects

Since the researchers have limited the study to jeepneys that take the route of UP Diliman-Philcoa, UP Diliman-Pantranco, and UP Diliman-SM North, only these jeepneys were measured. Also, the drivers of the chosen jeepneys were the only ones interviewed. Convenience sampling was used for the study. Only nine (9) jeepneys and drivers were involved, with three (3) taken from each route. They were selected randomly at the terminal on the scheduled day for measurement and interview.

2.4. Gathering of data

A scheduled day was allotted for all the measurements and interviews. The researchers went to the three (3) terminals of the different routes to acquire the needed data.

The name of the driver, the plate number of the jeepney, and the route were all written down for reference. The researchers made use of measuring tapes to ensure precise and accurate measurements; however, it is inevitable that some measurements were estimated due to lack of advanced instruments. The necessary vehicle component measurements and relative distances were all measured and inputted in the data forms. The survey forms were accomplished immediately by the researchers during the interview of the jeepney drivers.

After gathering all the data needed, the measurements and other data taken from the survey were tabulated and consolidated for data analysis.

3. Analysis

3.1. Data collection and presentation

Based from the oral survey conducted among the respondents, it was deduced that a regular driver works at an average of 10.14 hours each day, 4 to 5 days within a week.

There is in fact an overwhelming similarity in the answers of the interviewed drivers. They are all contented with the tolerable state of their workspace. The drivers are satisfied even if they are restricted to a small leg room, they have to bend just to see the traffic light, and/or they have to enter the passenger's side just to get to the driver's seat. Even if the respondents claim that they are at ease in their present condition, they all confirm that body ache and other discomfort are expected after each working day. These results from the interviews verify that there are definitely ergonomic problems that exist. The drivers just choose to ignore these problems simply because there will be monetary costs in solving these problems and because they have grown accustomed to these conditions.

Aside from the summary of the interviews, the researchers have gathered the measurements necessary for this study. Table 1 shows the average values of the measurements (in centimeters) obtained from the jeepneys chosen for the study. These measurement results were used in the succeeding analyses of this study.

Table 1. Measurement Data of Jeepneys.

Quantitative Criteria		Ave (cm)	Quantitative Criteria		Ave (cm)
Driver's Seat	Area of Driver Seat	57 x 40	Windshield	Glass Height	32.56
	Overall Height of Driver Seat	86.33		Glass Width	120.67
	Height of Back Rest	53.89		Area Covered by Route Sign Boards	312.44
	Height of Seat from the Floor	32.44		Distance of Seat from Sign Board	85.00
	Distance from Dashboard	30.00		Overall Front Width of Jeepney	142.44
	Distance from Foot Controls	27.89			
			Mirrors	Total Distance Between Side Mirrors	182.22

Quantitative Criteria		Ave (cm)	Quantitative Criteria		Ave (cm)
Driver's Entrance	Width of Entrance	41.67		Height of Side Mirror	25.33
	Height of Entrance	93.22		Width of Side Mirror	16.33
	Height of Entrance Base from the Floor	18.67		Rear-view Mirror Area	9 x 71
	Height of Entrance Base from Ground	67.56	Steering Wheel	Diameter	39.33
Pedals	Position of Pedals from Clutch to Break	13.33		Distance between Wheel and Seat	2.33
	Position of Pedals from Break to Gas	17.44	Shift Stick	Distance of Shift Stick	59.67
				Height of Stick from Jeepney Floor	31.11

3.2. Analysis of driver's seat

From the measurement and assessment of the jeepneys, the researchers observed that not all of the seats are ergonomically designed. Table 2 below shows the percentage of jeepneys that follow an ergonomic design – having seat depth, head rest, and back rest inclination.

Table 2. Driver's Seat Assessment.

Driver's Seat Assessment	Percentage (%)
Seat with Depth	56
Seat with Head Rest	44
Back Rest with Inclination	56

The average back rest height, excluding the head rest, is 53.89 cm; while the average back rest height with head rest is 73.6. Comparing these to the anthropometric data which provides an average sitting height of 84.84 cm and with allowable difference of 5 cm, 56% of the seats that do not have head rests are inadequate to provide a comfortable position for the driver. And even with the existence of a head rest, the driver's seat back rest height is still inadequate. Aside from the discomfort due to the absence of cushion for the driver's seat, the lack of back rest and head rest, together with the lack of proper inclination, causes more discomfort for the driver. The driver is forced to maintain an awkward posture while driving.

3.3. Analysis of leg room

With the average height of the seat cushion from the floor being 32.44 cm and average distance from the base of the seat to the foot controls being 27.89 cm, the mobility space for the driver's legs was computed which resulted to approximately 42.8 cm. Comparing this to the average anthropometric measurement which provides an average lower leg length of 45.27 cm, this difference can be accounted to take minimal effect on the ergonomics of the workspace.

However, since the average length of the lower leg of Filipino workers (45.27 cm) is considerably larger than the average measure of the height of the driver's seat (32.44 cm), this results to discomfort in the sitting position of the average driver due to the difference in these two heights. This difference has an effect to the angle of the knees which is forced to be positioned at an acute angle, when it is supposed to be positioned at an angle greater than 90 degrees when in the relaxed sitting position, thus making the leg room non-ergonomic.

3.4. Analysis of rear-view and side mirrors

While the rear-view mirrors that are usually located at the top of the windshield provide the drivers a convenient view of the interior and rear external of the vehicle, these are usually fixed and could not be adjusted to the preference of the driver. Almost 44% of the jeepneys have a fixed rear-view mirror. Because of this, some drivers have found the need to add another adjustable mirror to add to their convenience.

Aside from the rear-view mirror, the side mirrors of jeepneys had been causing driver's unwanted difficulty because of its constant adjustments, especially the one near the passenger's seat. These mirrors are prone to being moved due to its proximity with the passengers. While it can be adjusted easily for most times, it still increases the risk of accidents due to absence of the proper side view.

3.5. Qualitative assessment of driver's condition

According to the drivers interviewed, occurrences like time-to-time adjustment of the side mirrors do little to no effect to their driving conditions. It was also inferred that jeepney drivers consider the size of the side mirrors adequate for their line of sight as well as the dimension of their windshield. They have claimed that they are able to see the road with no difficulty unless it is raining thus they manually operate their wipers. A significant count of the sample has also claimed that there is only minimal consequence that the route sign boards placed on the windshield are hindrances to their line of vision. They simply remove these boards when the jeep is full and/or near the terminal. Lastly, almost hundred percent of the respondents interviewed assert that the changing of body positions while driving is a necessity especially during work hours, not to mention their unanimous claim that having a softer and more comfortable seat will provide greater benefit in their working condition especially in easing comfort and preventing back pain.

There is in fact an overwhelming similarity with the answers of the interviewed drivers. They are all contented with the tolerable state of their work space. The drivers are satisfied even if they are restricted into a small leg room, they have to bend just to see the traffic light, or they have to enter the passenger's side just to get to the driver's seat. Even if the respondents claim that they are at ease in their present condition, they all also agreed that body ache and other discomfort are expected after each working day. This result of the interviews verifies that there are definitely ergonomic problems that exist. The drivers just choose to ignore these problems simply because there will be monetary costs in solving these problems and because they have grown accustomed to these conditions.

4. Conclusion

With these analyses, the researchers had found out that the current dimensions of the jeepneys are inadequate and not ergonomic enough to fit the built of a driver based from the anthropometric measurements of average Filipino workers. However, by looking at the complete set of data gathered, the dimensions of these jeepney units vary in a significantly large quantity. It is in this light that the researchers deem it important to redesign the dimensions of the jeepney such that the average value of the measurements gathered in this study is followed.

Below is the table of measurements showing the most favorable workplace dimensions that will fit the average Filipino jeepneydriver. These measurements lessen the risk of having prolonged undesired health conditions such as back pains and fatigue that are commonly experienced by drivers.

Table 3. Measurements of Proposed Layout.

Quantitative Criteria	Average Measurement (cm)
Overall Height of Driver Seat	128.27
Height of Back Rest	84.84
Height of Seat Proper from the Floor	43.33
Diagonal Distance from Edge of Seat Proper to Foot Controls	45.27
Distance of Steering Wheel from the Floor	22.23

All the average measurements taken from the data gathering were assessed to be adequate for the average Filipino jeepney driver. All else will be maintained except the 4 measurements specified in the proposed workspace measurements above. These measurements with an allowable difference of 5cm should be followed in the design of the new jeepneys to fit the anthropometric measurements of the average driver.

5. Recommendations

Aside from the proposed workspace measurements for the jeepney, the researchers recommend the following modifications for the specified vehicle components.

5.1. Driver's seat

There were two-types of driver's seat that the researchers encountered during data gathering. First was the properly contoured driver's seat of another vehicle mounted in the jeepney. Second was the plain "bench" type seat without any contouring. The drivers naturally preferred to have the driver's seat that came from the standard vehicle mainly because of the comfort that the particular seat offered. However, the researchers observed that the drivers still use an additional back rest even if the jeepney was installed with the preferred seat. The drivers with the preferred seats still changed their position during driving because of the strain and fatigue they experience. For these reasons, the researchers recommend that the driver's seat should be a properly contoured driver's seat with the following dimensions to properly suit the jeepney. A head rest must also be provided since not all jeepneys provide a head rest.

5.2. Steering wheel

The steering wheel did its purpose ergonomically well with respect to size even if it was not specifically made for the jeepney. The problem concerning the steering wheel came from the distance of the steering wheel to the driver's seat. Most of the jeepneys do not have any distance from the driver seat which means that the space for the driver to move freely is reduced. Although the drivers claim that they are used to the current position of the steering wheel, the researchers still recommend putting an adequate distance between the steering wheel and the driver's seat to provide ample space for the driver.

5.3. Windshield

The narrow height ended up as the main problem for the windshield. The drivers had to bend forward to see the traffic light or call passengers. This contributes to the frequent complaint of the drivers of back aches after a working day. The sign boards on the windshield are not much of a hindrance for them to see the road clearly but they are more comfortable when they remove the sign usually when the jeep is full of passengers or if they are already approaching the jeepney terminal. Thus, the researchers propose to increase the height of the windshield and completely remove the sign placed on the side of the windshield. The researchers recommend changing the exterior design of the jeepney just above the windshield. Instead of an irrelevant design, the route could be written above the windshield, thus making it more visible and eliminating the obstruction of a separate sign board.

5.4. Driver's entrance

The driver's entrance is significantly adequate for an average size driver to go in and out of the jeep. However, the drivers usually use the passengers' side to go in and out of the jeepney mainly because of the spare tire that hangs beside the driver's entrance. The researchers recommend moving the spare tire where it would not block any part of the driver's entrance. Some of the jeepneys actually place their spare tire in a small compartment underneath, where the plate number on the back of the jeepney is attached. This is more preferable than the usual place of the spare tire which is beside the driver.

6. Areas for further study

While this study focused on the assessment and improvement of the workplace design of the jeepney drivers, further studies may also include other parts of the entire jeepney. This includes the area for passengers and the various aspects that affect their mobility and comfort. Further studies may also delve into the assessment of more parts of the vehicle that concerns health and safety of both drivers and passengers, some of which consist of the fare payment collection system and the passenger entrance and exit.

Other studies may also look into other factors that may significantly affect the working condition of the drivers such as vibration caused by the engine as well as the amount of force exerted by the driver on the steering wheel and other driving controls. Other aspect that future researchers may delve into as well is the age of the engine being used, which may contribute significant effect in the operations of the jeepney as well as in the safety of the driver.

Aside from this, a wider sample count of workplace measurements may also be gathered in order to obtain a better representation of the over-all actual data. By obtaining a larger pool of sample dimensions including units from outside the three jeepney routes specified in this study, the results can be used in a wider application.

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